FALL PLANTING OF PINE ON UPLAND SOILS OF SOUTHERN ILLINOIS

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FOREST EXPERIMENT STATION
Columbus 15, Ohio

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TECHNICAL PAPER NO. 118 FEBRUARY 1951

This report is from the

DIVISION OF FOREST MANAGEMENT

A. G. Chapman, Division Chief

These members of the Central States Forest Experiment Station have helped the author prepare this Technical Paper: Richard D. Lane, Work Center Leader of the Carbondale Branch; Alberta M. Hiatt and Cleo Caraway, Secretaries; and Kenneth G. Johnson, Station Editor.

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Nearly all tree planting in the southern part of the Central States region is done during a six to eight weeks period starting about March 1. This restricts any planting program and results in a heavy spring work load. Successful fall planting would speed up the planting job and permit better work-load distribution during expanded planting programs. Some fall planting was tried in the thirties during the rush of reforestation work by the Civilian Conservation Corps. However, because these plantings generally failed, little fall planting has been done in recent years.

Earlier failures of fall planting were caused mainly by frost heaving on areas with relatively sparse vegetation. Some additional mortality was caused by excessive drying of plant tissues during the first winter. Many planting sites had been freshly abandoned as farm land and had only a sparse cover of annual weeds and grasses. The soil was essentially bare, little mulch had accumulated, and conditions were right for maximum frost action on the surface soil.

By 1947-48 ecological succession and fire-control practices in some of these areas had greatly altered the cover types on the old abandoned fields (figures 1 and 2). On the better sites perennial vegetation of broomsedge (Andropogan sp.) or broomsedge mixed with scattered weeds, brush, and blackberry briars was well established. A cover of surface mulch was present and the soil structure was much better than that on freshly abandoned fields. The poorer, more heavily eroded sites and those more recently abandoned still have annual weeds and grasses, little mulch on the surface, and poorer soil structure. Because of this natural ecological succession and resulting changes in the site, the possibilities of fall planting are greatly improved.

Successful fall planting would have definite advantages over the present practice which restricts planting to the spring. It would reduce the spring work load at a time when the fire season is at its worst. It would also reduce the nursery spring work load. It would approximately double the time available for planting and thus enable a more rapid completion of the reforestation job. This would be especially important if the work were suddenly and greatly expanded. If necessary to gain these advantages, a small sacrifice in survival could well be accepted. Because soils are drier in the fall, machine planting is usually easier although other factors may outweigh this advantage. The series of studies reported in this paper were designed to explore fall and spring planting as related to planting methods and vegetational cover types.

Figure 1.--Typical broomsedge cover. Frost heaving of fall-planted trees would be slight on this old field cover type.

Figure 2.--Moderately heavy cover of annual weeds and grasses. Succession has not progressed to broomsedge and some frost heaving of fall-planted trees could be expected, especially if scalps are removed.

GENERAL DESCRIPTION OF STUDIES

EXPERIMENTAL PLOTS

Cover types were sampled by nine experimental blocks on the Kaskaskia Experimental Forest and two Ranger Districts of the Shawnee National Forest in the southern Illinois uplands. Each block consisted of four plots, one for each of the four planting methods tested. Plots were split; one-half was planted in the fall of 1947 and one-half in the spring of 1948. Each subplot contained 40 planted trees of 1-0 shortleaf pine (Pinus echinata Mill.) plantable grade stock grown at the Illinois Union State Nursery. In this way each planting method was tested on nine 80-tree plots located in several counties.

The classification of cover types sampled is given below. Areas nearly bare or with a light cover (density less than about 0.5[1/]) were omitted from the experiment as poor fall-planting risks.

Predominant vegetation	Approximate density
Annual weeds and grasses	0.5 to 0.8
Broomsedge or broomsedge mixed with briars and some annual weeds	0.6 to 0.9
Broomsedge mixed with sassafras-persimmon-hickory brush	0.7 to 0.9

The planting methods tested are as follows. Selection was based on expected effect on frost heaving and on speed of planting.

1. Side-hole method[2/] with a 10-inch scalp removed.
2. Mattock-slit method[2/] with a 10-inch scalp removed.
3. Side-hole method, not scalped.
4. Mattock-slit method, not scalped.

A rather serious but unavoidable fault of the plot experiments was that the fall planting was not done until the second and third weeks of December. The planting stock had been in cold storage for about a month but looked to be in good condition. Freezing weather started the last week in December and continued intermittently throughout the winter. The trees had no chance for fall root growth and inspection in late February and early March showed the tops of many trees to be dead and dry, regardless of frost heaving.

Examination in June showed that many trees had sprouted from the roots or main stem but the lateness of the fall planting made these plots

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1/ Estimated proportion of ground covered or shaded by vegetational cover.

2/ For a description of these methods see: Tree Planting, USDA Farmers' Bul. No. 1994, by Leon S. Minckler and Arthur G. Chapman.

useless as a test of fall planting survival. They did show clearly the effect of cover type and planting method on frost heaving and the relation between planting method and speed of planting.

FALL-PLANTED PILOT PLANTS[3/]

To test early fall planting of 1-0 shortleaf pine on the most promising cover types and by the most successful and cheapest methods, two series of pilot plants were established, one in October 1948, the other in October 1949. The areas selected had a cover of broomsedge with a few scattered patches of annual weeds. Planting methods used and sizes of areas planted in the first series were as follows:

1. Mattock-slit method, unscalped; 0.9 acre.
2. Mattock side-hole method with a 6-inch scalp removed; 0.6 acre.
3. Lowther tree planting machine; 1.0 acre.

In the second series established a year later the bar-slit and mattock-slit, both unscalped, were used to plant four 1-acre areas. Two of these areas were planted with the bar and two with the mattock.

RESULTS

EXPERIMENTAL PLOTS

Spring Planting

For the 36 spring-planted plots, first year survival was good for all planting methods and for all experimental blocks (table 1). None of the plots had less than 73 percent survival and the average for all plots was 90 percent. Average tree height at the end of the first year was almost identical for the four planting methods.

Speed of planting by the different methods varied considerably. This was shown by time studies of the nine planted plots for each planting method. The mattock-slit method, unscalped, was 1.8 times as fast as the side-hole method with a 10-inch scalp removed. Based on number of live trees (first year survival) obtained per man-hour of planting time the mattock-slit method, unscalped, gave 1.7 times more trees than the side-hole with scalp removed and about 1.3 times more than the other methods (table 1).

The planting speeds shown in table 1 are relative. The absolute values shown in the table would not necessarily be obtained on an actual field planting job. Large scale planting might be affected by many different factors.

3/ A test area large enough to simulate actual working conditions and give relative cost data.

Table 1.--Planting success and speed for 1948 spring planted shortleaf pine by different planting methods

Planting method	First year mean survival	Range of survival for the 9 plots	Trees planted per man-hour 1/	Live trees obtained per man-hour of planting time
	Percent	Percent	Number	Number
10" scalp removed:				
Side-hole	91	80-98	59	53
Mattock-slit	94	80-100	69	65
Not scalped:				
Side-hole	90	80-100	76	68
Mattock-slit	83	73-93	107	89

1/ Data are relative and apply only to the particular conditions encountered.

Fall Planting

About 27 percent of all trees planted on scalped spots were frost heaved but only 6 percent of the trees planted on unscalped spots were heaved. Frost heaving caused about 56 percent of the mortality on scalped spots and 17 percent on unscalped spots. The mattock-slit method, unscalped, had the least amount of cover disturbance and only 9 percent of the dead trees were frost heaved (table 2). In June of the first season over half of the live trees were sprouts from the root collar.

When the blocks having different cover types are segregated (table 3), it is clear that cover type as well as scalping greatly influenced frost heaving. On blocks covered by annual weeds and grasses, 54 percent of the scalp-planted trees were heaved while only 14 percent were heaved on blocks with perennial cover types (table 3). Where scalps were not removed, cover type was still effective but somewhat less important. On the annual weeds and grasses type, 83 percent of mortality was caused by frost heaving for scalp-planted trees. On perennial type cover without scalps removed the figure was 10 percent. Frost heaving had little effect on mortality on broomsedge cover when scalps were not removed.

Survival of late fall planted pine at the end of the first year was poor on annual type vegetation and only fair on perennial type vegetation (table 4). The general low level of survival on the experimental plots prevented definite conclusions regarding the best method for fall planting. As previously discussed, this relatively low survival was almost surely caused by the December planting and consequent winterdrying of the trees through lack of proper moisture in frozen soil. Certainly frost heaving caused little of the mortality on broomsedge sites and later results on pilot plant tests substantiated late fall planting as the cause.

Table 2.--Frost heaving of 1947 late fall planted shortleaf pine for different planting methods[1/]

Planting method	Total trees frost heaved	Dead trees frost heaved	Live trees sprouted[2/]
	Percent	Percent	Percent
10" scalp removed:			
Side-hole	24	53	62
Mattock-slit	31	60	61
Not scalped:			
Side-hole	9	25	60
Mattock-slit	4	9	49

1/ Based on nine 40-tree plots for each planting method. Examination made in late June following December planting.

2/ Percent of all "surviving" trees shown to be alive by green sprouts from the original seedling.

Table 3.--Frost heaving of 1947 late fall planted shortleaf pine as related to vegetational cover and scalping[1/]

Vegetational cover type[2/]	Total trees frost heaved		Dead trees frost heaved	
	Scalped	Not scalped	Scalped	Not scalped
	Percent	Percent	Percent	Percent
Annual weeds and grasses	54	10	83	30
Broomsedge or sedge and briars	13	4	51	10
Mixed broomsedge and brush	15	5	39	10

1/ Each percentage value in table is based on 6 plots of 40 planted trees each.

2/ Each type represented by three planting areas.

Table 4.--First year survival of 1947 late fall planted shortleaf pine as related to vegetational cover types and planting methods[1]/

Vegetational cover type	Planting methods				
	Side-hole with 10" scalp removed	Mattock-slit with 10" scalp removed	Side-hole not scalped	Mattock-slit not scalped	All methods combined
	Percent	Percent	Percent	Percent	Percent
Annual weeds and grasses	42	37	44	39	40
Broomsedge or sedge and briars	69	66	60	48	61
Mixed broomsedge and brush	73	68	64	39	61

1/ Each percentage value in table is based on three plots of 40 planted trees each.

Table 5.--Survival and frost heaving of early fall planted shortleaf pine by different planting methods; 1948 pilot plant areas

Planting method	Date planted	Pilot plant area	First year survival	Total trees frost heaved	Dead trees frost heaved	Live trees frost heaved
		Acres	Percent	Percent	Percent	Percent
Mattock-slit, unscalped	Oct. 25 1948	0.9	75	6	22	1
Mattock side-hole with 6" scalp removed	Oct. 25 1948	0.6	69	38	85	16
Lowther tree planting machine	Nov. 23 1948	1.0	45	51	83	12

FALL-PLANTED PILOT PLANTS

Survival and Frost Heaving

The first series of fall planting pilot plants was set up during October 1948 to test early fall planting on a broomsedge cover type by (1) an intensive method (side-hole with scalp removed) and (2) the cheapest method and the one showing the least frost heaving (mattock-slit, unscalped). The Lowther planting machine was also used as a first trial of fall planting. If successful it could replace planting in the spring when the heavy clay soils are often too wet for machine planting.

The results of early fall planting in 1948 (table 5) were satisfactory and showed very little frost heaving for the mattock-slit method, unscalped. Fall survival was about eight percent less than spring survival for the same planting method (table 1). The side-hole method with a six-inch scalp removed gave only fair survival and showed considerable frost heaving (table 5). Machine fall planting gave poor survival and over half of the trees were frost heaved. Perhaps this was due to the relatively late planting date. However, trees were not as firmly packed as desirable and much of the vegetation and natural mulch were scraped away from the planted trees by the machine. In this trial frost heaving was so extensive that the method was impractical, but further tests are needed for this and other types of planting machines.

The second series of fall planting pilot plants was established on broomsedge cover types October 17 and 18, 1949. Results on the four one-acre areas were as follows:

1949 pilot plants (Not scalped)	First year survival (Percent)
Bar-slit planting, area No. 1	89
Bar-slit planting, area No. 2	78
Mattock-slit planting, area No. 1	76
Mattock-slit planting, area No. 2	75

The evidence is clear that frost heaving on areas with broomsedge cover was practically eliminated by planting with the mattock or bar-slit method, unscalped. Good survival was obtained by planting in October which allowed fall root growth and thus helped prevent winter drying of the trees. An important precaution is to use planting stock that has "hardened off" before lifting from the nursery. Ordinarily, this process is complete by about the middle of October in Central States nurseries.

Costs of Planting

The man-hours labor cost per acre and per 1000 live trees obtained shows that the mattock-slit method, unscalped, and the bar-slit method were much cheaper than the side-hole method with 6" scalp removed (table 6).

The Lowther planting machine planted 1160 trees per hour, but the dollar costs per acre will depend upon the type of power used. The fall planting survival was too low to recommend machine fall planting without further trials with different machines at earlier fall dates and with various soil moisture conditions.

Table 6.--Costs in labor for early fall planted shortleaf pine by different planting methods; pilot plant areas

Planting method and pilot plant	Area of pilot plant	Trees planted per man-hour	Live trees obtained per hour of planting time
	Acres	Number	Number
Mattock side-hole, 6" scalp removed, 1948 series	0.6	65	45
Mattock-slit, not scalped, 1948 series	0.9	110	83
Mattock-slit, not scalped, 1949 series	Two 1-acre areas	113	85
Bar-slit, not scalped, 1949 series	Two 1-acre areas	92	77

RECOMMENDATIONS

The advance in ecological succession on large areas of southern Illinois farm lands abandoned in the mid-thirties has made these areas and similar neighboring areas suitable for fall planting. Retirement of land from agriculture has been much slower since that time.

These are the recommended conditions for successful planting of pine:

Fall hand planting

Cover type : Broomsedge, broomsedge mixed with briars and/or brush, and mixed broomsedge and annual weeds and grasses but not dense brush and briars.

Time of planting: About October 10 to November 10.

Planting method : Mattock or bar-slit, unscalped. Soil should be packed firmly around trees.

Planting stock : Stock should be "hardened off" before lifting from nursery beds and of plantable grade. Larger, more vigorous stock is more important for fall than for spring planting.

Spring hand planting

Cover type : Any type except dense brush and briars.

Time of planting: About March 1 to April 20.

Planting method : Mattock or bar-slit, unscalped.

Machine planting

Results of this study showed poor results for fall machine planting, but this method should be successful if the trees can be set in the ground tight enough to prevent frost heaving. Further tests are needed. Spring machine planting is usually successful and cheaper than hand methods, but planting machines will not operate satisfactorily on wet, sticky clay soils.

CONCLUSIONS

Conclusions that can be drawn from this series of studies are:

1. Spring planting survival was excellent and did not vary greatly by planting methods or cover types.

2. Speed and cost of planting varied by planting methods. The mattock-slit, unscalped, was the fastest and cheapest of those used.

3. Frost heaving was severe only for methods with scalps removed.

4. Frost heaving was most severe in cover types of annual weeds and grasses. Trees in dense perennial growth (broomsedge and/or light brush) suffered very little from frost heaving.

5. Frost heaving caused most of the tree mortality for methods with scalps removed used on annual cover types. It caused only 10 percent of mortality on areas with broomsedge where scalps were not removed.

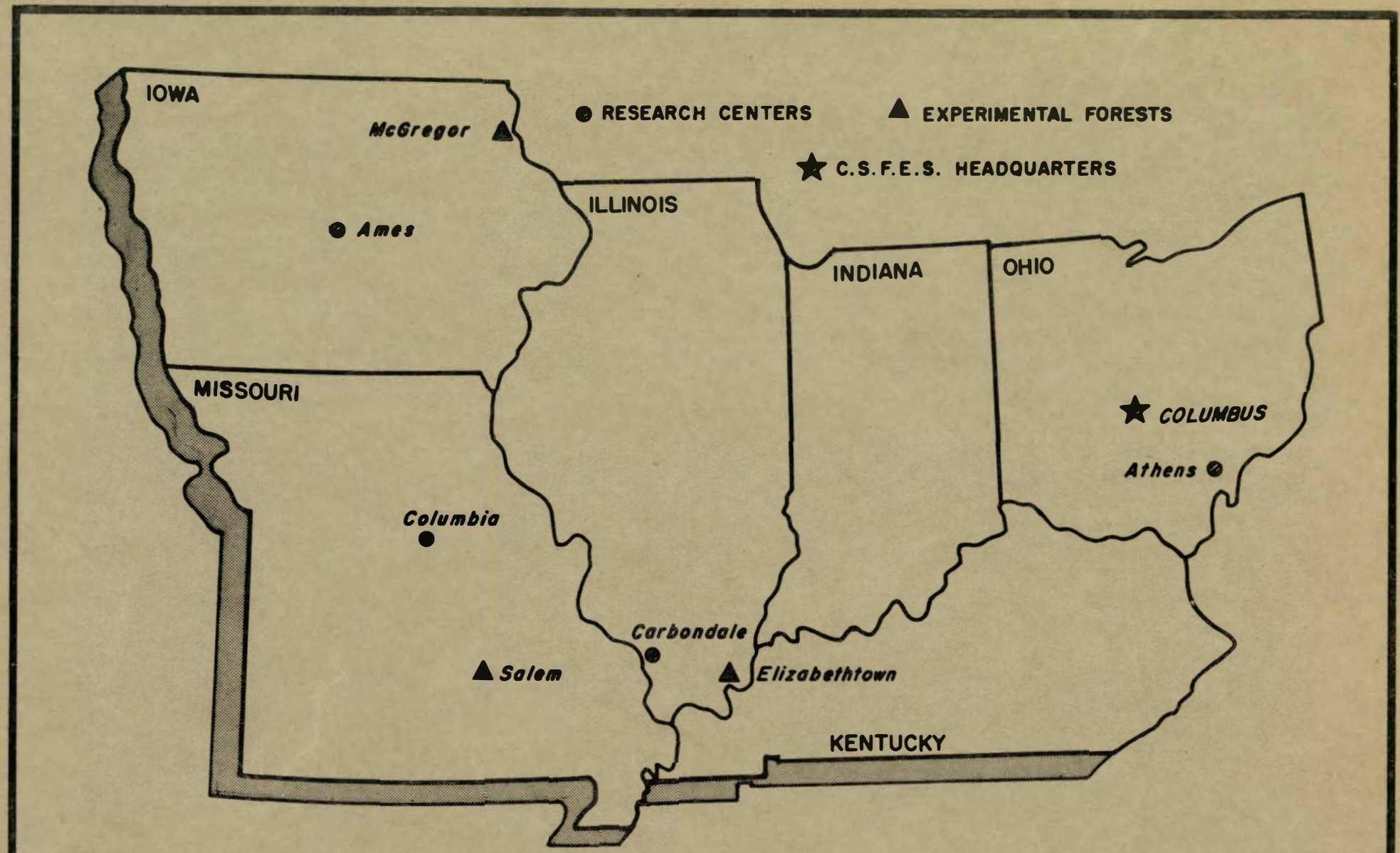
6. December planting of experimental plots caused a low level of survival and prevented definite recommendations on methods for fall planting but furnished a basis for further pilot plant tests.

7. October planting in pilot plants over a 2-year period on broomsedge cover types was successful for the mattock-slit and bar-slit methods, unscalped. Frost heaving was negligible.

8. The mattock-slit and bar-slit methods, unscalped, gave an average survival for early fall planting only about four percent less than for spring planting with the mattock-slit method.

9. Fall planting with the Lowther planting machine gave only 45 percent survival. About 85 percent of the mortality was caused by frost heaving. Further tests are needed with this and other machines.

10. The labor cost per 1000 live trees obtained for the mattock-slit method, unscalped, and the bar-slit method was about 53-58 percent of that for the mattock side-hole method with a 6-inch scalp removed. Planting by machine is cheaper than by hand but will not be practical for fall planting unless better survival can be obtained.



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